A REVISION OF THE GENERA WITH MICROSCLERES INCLUDED, OR PROVISIONALLY INCLUDED, IN THE FAMILY *AXINELLIDÆ;* WITH DESCRIPTIONS OF SOME AUSTRALIAN SPECIES. Part i. (Porifera.)

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(Plates xxi.-xxix., figs.1-2; also xxxix., figs.6,7: and Text-figs.1-9.)

Genus Trachycladus Carter.

Definition.—Axinellidæ(?) typically of arborescent habit; with an axially condensed, reticulate skeleton of spiculo-spongin fibre. The megascleres are diactinal and of a single category, varying in form from oxea to strongyla. The characteristic microscleres are spinispirulæ, to which are usually added smooth microstrongyla.

Type-species, *T. lævispirulifer* Carter.

Inclusive of those here added to it, Trachycladus comprises now seven species (together with several varieties), all of which are from the southern and south-eastern coasts of Australia. The hitherto-described species referable to the genus are four, viz., *T. lævispirulifer* Carter (the type-species), and the three described by Lendenfeld, very imperfectly, under the names *Spirophora digitata*, *S. bacterium*, and *Spirophorella digitata*; but, for reasons already indicated in my previous paper, I reject the last-named, relegating it to the synonymy of *T. digitatus*—a redescription of which is given below. The other two species, *T. lævispirulifer* and *T. bacterium*, are apparently unrepresented among those examined by me; but the latter may prove to be identical with *T. pustulosus*, sp.n. The specimens from Port Phillip recorded and briefly described as examples of *T. lævispirulifer* by Dendy(7) appear to me to represent at least two distinct forms, which I describe below as varieties of *T. reteporosus*, sp.n., and of *T. digitatus* respectively.

In the characters which it combines, the genus is a most anomalous one; and the question of its relationship affords scope for considerable speculation. The form of the spinispirulæ irresistibly suggests their derivation from spirasters; and this view of their origin receives strong support from the fact that identically similar spicules—which undoubtedly are derived from spirasters—occur in *Spirastrella* (?) *spinispirulifera* (Carter) Dendy(7), and *Spirastrella* (?) *dilatata* (Kieschnick) Thiele(39), and from the fact that, in the latter species (which is apparently unique in this respect among the Spirastrellidæ), the megascleres are united into definite fibres by means of spongin. Also in support of this view, is the fact of the presence of microstrongyla. On the other hand, in structural features of the skeleton, the genus conforms to a type which is characteristic of genera in which the microscleres are sigmata or are such as are known to occur in association with sigmata. Trachycladus, therefore, appears to form a connecting link between the Spirastrellidæ and the sigmatophorous section of the Monaxonida, and provides ground for the view that these two groups are derived from a common Monaxonid stem.*

As the several species agree very closely in by far the greater number of their characters, a preliminary general account of them is desirable in order to obviate to some extent the necessity of repetition in their separate descriptions.

With the possible exception of *T. bacterium*—which is described by Lendenfeld as "eiformig, mit schmaler Basis festgewachsen"—all the species are of ramose habit, typically stipitate and more or less arborescent, with branches which are circular or nearly so in cross-section (occasionally somewhat compressed in *T. reteporosus*), and never of considerable stoutness; in *T. pustulosus* alone, the branches generally remain much abbreviated, closely crowded, and more or less coalesced together proximally, thus sometimes (through excessive reduction and fusion) producing a

* In this connection, I may mention that evidence is not wanting which would justify the hypothesis that sigmata and chelæ have originated from spirasters, perhaps independently; and it is even possible that the acanthoscleres of the Desmacidonidæ are similarly derived.

compact solid mass, or head, with digitiform protuberances (Pl. xxi., fig.5); occasionally, in the case of *T. reteporosus*, the sponge may remain unbranched—consisting simply of a long and slender, undivided stem. According to the species (or variety), the branches may be either cylindrical, distally expanded (*i.e.*, more or less clavate), or gradually tapered. Anastomosis between the branches occurs to a greater or less extent almost invariably, except perhaps in the case of *T. reteporosus*. The mode of branching is probably never dichotomous, though occasionally it may appear so; normally at any rate, the branches arise laterally and adventitiously.

The oscula are of small size, very seldom as much as 1 mm. in diameter, and are generally scattered over the surface irregularly; in *T. reteporosus*, however, they show a decided tendency to be arranged in longitudinal series, especially along the edges of the branches when these are compressed. In *T. pustulosus*, the oscula are restricted almost entirely to the distal parts of the branches, while in *T. bacterium* they are said to occur arranged in groups.

The surface is smooth, or is provided with numerous minute prominences (up-pushings of the dermal layer) produced by the extremities of impinging skeletal fibres. These elevations constitute a marked feature of the surface only in *T. pustulosus* (and *T. bacterium*?) in which they have the appearance of small pimples, and in *T. scabrosus* (Pl. xxi., fig.4; Pl. xxviii., fig.6), in which they take the form of minute sharp conuli; in the remaining species, they are either imperceptible or produce merely the appearance of granulation. In any case, whether surface-elevations occur or not, each point on the surface at the extremity of a skeletal fibre is the location of a small area over which the dermal membrane is adherent to the underlying tissues and free from dermal pores, whilst elsewhere it overlies subdermal spaces and is perforated by numerous pores. The pores are either scattered singly and for the most part subequidistantly, at an average distance apart not much exceeding their own diameter, as, for example, in *T. digitatus* and its varieties (Pls. xxvi., xxviii.);

or they are closely arranged in subcircular, sieve-like groups, as in *T. reteporosus* and *T. pustulosus* (Pl. xxvi., figs.4, 5, 7, 8; Pl. xxvii., figs.5, 6). In the latter species, the surface presents a minutely reticulate appearance.

Dried specimens are whitish on the surface, owing to the presence of a thin dermal crust of spinispiral microscleres; in alcohol, the colour varies in the different species, from whitish-grey to pale orange-yellow. The colour of living specimens—known so far only in the case of *T. reteporosus*, in which it is brilliant orange, red or scarlet—is probably always to some extent determined by, or dependent upon, that of a symbiotic Myxophycean alga, which appears to be invariably present in all the species, often in enormous numbers.

The main skeleton, which is composed of non-plumose spiculospongin fibres, is almost exactly similar in its conformation (except, presumably, in *T. bacterium*) to that described by Vosmaer* as typical of the genus *Axinella* (s.str.). In the central region of each branch, it forms an abruptly delimited dense core, or axial fune, composed of ramifying and interuniting longitudinal main fibres additionally connected (more or less obliquely) by a greater or lesser number of transverse fibres, and presenting (in longitudinal section) a somewhat lattice-like arrangement (Pl. xxvi., fig.1); and extra-axially it consists mainly or almost solely of very sparsely ramifying, radial fibres, which arising as branches from the longitudinal fibres (usually at some distance within the axial fune), run outwards to the surface at approximately equal distances apart, and are connected, only at irregular and usually distant intervals, by spongin-ensheathed single spicules and by paucispicular fibres of a single spicule's length (Pl. xxv., fig.1). The fibres are composed chiefly or almost entirely of spicules, which are arranged for the most part parallelly or nearly so (though not, as a rule, very compactly nor in a very orderly fashion); and this arrangement is maintained to the very ex-

* Vosmaer, G. C. J., "On the distinction between the genera *Axinella*, *Phakellia*, *Acanthella*, etc." Zool. Jahrb. Suppl. xv., 1912, p.310, Pl. xvi., figs.5, 6.

tremities of the (radial) fibres, the terminal spicules of which show no tendency to spread penicillately. The outlines of the fibres, as seen in cross-section, are very irregular (Pl. xxvi., fig. 9). In the axial region of the skeleton, the fibre-spicules are less compactly and less regularly arranged than in the radial fibres, and the appearance of irregularity is much increased by the presence of many additional spicules lying between the fibres; outside the axial region, interstitial megascleres are exceedingly rare. The characteristic microscleres—the spinispirulæ—are scattered always in great abundance throughout all parts of the interior, and at the surface occur closely crowded in a well-defined layer, which constitutes the dermal skeleton. The microstrongyla, when present, are confined to the extra-axial choanosome.

The chief specific differences, in so far as structural features of the skeleton are concerned, are with respect to:—(i.) the density of the axial fune: (ii.) the ratio between the diameter of the fune and that of the whole branch; (iii.) the stoutness of the skeletal fibres; (iv.) the amount of spongin entering into the composition of the fibres; (v.) the frequency of connection between the radial fibres by means of transverse fibres; and (vi.) the angle of inclination of the radial fibres, *i.e.*, their direction relatively to the longitudinal axis of the branch. A further difference, however, is presented by *T. pustulosus*, in which the skeleton is axially condensed only in the stalk and in the lowermost portions of the branches: while in *T. bacterium*, apparently, an axial condensation is not developed. In order most readily to perceive, and also most accurately to determine, the distinctive characters of the skeleton in the different species, it is necessary to study the skeleton freed of the soft parts.

The megascleres are slightly curved oxea and strongyla (and rare styli), occurring intermingled, and connected by intermediate forms; the oxea, on the average, are slightly longer and stouter than the strongyla and not so nearly of uniform diameter, but otherwise differ from them only in the character of their extremities. Both in regard to the shape and the size of the megascleres, the two species differing most widely are *T. scabrosus*

and *T. reteporosus:* in the former, strongyla are extremely rare, and the megascleres are almost exclusively sharp-pointed, fusiform oxea, attaining a maximum size of 530 by 27 μ; in the latter, strongyla and oxea are about equally numerous, the oxea are mostly more or less blunt-pointed and but very slightly fusiform, and their maximum size usually does not exceed 300 by 8 μ. In most of the species, a certain proportion of the megascleres (apparently those alone which occur extra-fibrally in the axial region of the skeleton) are found to attain an increasingly larger size as one proceeds towards the older portions of the sponge, with the result that, in the stalk, the maximum size of the megascleres is notably greater than in the uppermost parts of the branches; and these largest spicules, even in the species in which strongyla abound, are almost without exception oxea. The spicules of the fibres are no larger in the stalk than elsewhere.

The spinispirulæ are minute, entirely spinulous, for the most part regularly corkscrew-shaped spicules, rarely of more than two complete turns; in addition, they comprise a series of simpler forms, of various shapes ranging from that of a much contort S, through C-shaped forms, to straight or nearly straight rods (Text-fig. 3). The proportionate number of these simpler forms varies in the different species, but the degree of variability in this respect, as well as in other characters of the spirulæ, is not sufficient to be of diagnostic value. An exception to this rule, however, is possibly afforded by the spirulæ of *T. lævispirulifer*, which have been described by Carter as smooth; but it is more probable that the spicules, in this case, were not examined under a sufficiently high power to render their spination visible.

The microstrongyla are inconstant in occurrence, and they may be either numerous or scarce, or perhaps sometimes entirely absent, in different specimens of the same species; at any rate, this was found to be the case in *T. digitatus* (typical variety), and *T. reteporosus* (var. ?)—of which alone a number of specimens were available for examination. That they are proper spicules, however, and not merely pathological products, is rendered certain by their degree of uniformity in size and shape. Occasional

malformed individuals (occurring least rarely in *T. digitatus*) are met with amongst them; and, in *T. pustulosus*, they are in part reduced to spheres: but otherwise they have the form of short straight rods, rounded at the extremities, often centrotylote, always quite smooth, and usually relatively stout.

The canal-system (Pl. xxiv., fig.3; Pl. xxv., fig.2) is of the aphodal type, with oval to spherical flagellated chambers, though with extremely short aphodi. The chambers measure from 25 to 35μ in diameter, and occur closely scattered throughout the entire extra-axial choanosome; within the region occupied by the axial skeleton, however, they are absent, except in the youngest portions of the sponge (*i.e.*, towards the extremities of the branches). In conformity with the symmetry of the skeleton, the main inhalant canals proceed from the subdermal spaces towards the interior in a radial direction, parallel to that of the radial skeletal fibres, and are traceable inwards almost to the axial fune; at their commencement, they are of such diameter as to be very distinctly visible to the naked eye, when a thin layer is pared from the surface (Pl. xxvi., fig.2). The subdermal spaces are inextensive—least so in *T. pustulosus*. The ectosomal layer, or dermal membrane, varies in thickness in the different species, from 50μ in *T. reteporosus* to (occasionally) 140μ in *T. fastigatus*, and, when best developed, has very much the appearance of a thin cortex; it is densely packed with spirulæ usually throughout, or nearly throughout, its entire thickness.

In none of the species were ova or embryos observed.

Trachycladus scabrosus, sp.nov.

(Pl. xxi., fig.4; Pl. xxiii., fig.9; Pl. xxviii., fig.6.)

Diagnosis.—Branches cylindrical, rather slender; of approximately uniform diameter throughout their length, Surface densely beset with small, sharp conuli formed by the extremities of the radial skeletal fibres. Dermal layer comparatively thin: superficially packed with spirulæ. Oscula and pores(?). Skeleton with an extremely dense axial fune of diameter exceeding the length of the radial fibres. Radial fibres directed nearly perpendicularly to the skeleton-axis, mostly between 120 and 170μ in stoutness, com-

posed almost solely of spicules. Megascleres, sharp-pointed fusiform oxea, rarely passing into strongyla, and less rarely into styli; maximum size, $480 \times 23\mu$ in the branches, occasionally as much as $530 \times 28\mu$ in the stalk. Microstrongyla scarce.

Loc.—Off Port Jackson. ("Thetis" Expedition).

External features.—The species is known from a single example (Pl. xxi., fig. 4), 108 mm. in total height, consisting of an elongated slender stalk and irregularly disposed cylindrical branches from 2·5 to 4 mm. in diameter. The specimen (which is invested over portion of the exterior by a calcareous bryozoan) is only imperfectly preserved, having evidently suffered some amount of dessication prior to being placed in alcohol—in consequence of which the dermal layer, while remaining quite intact, has to some extent shrunken inwards upon the underlying skeleton. To this circumstance, in all probability, is largely due the marked degree in which the surface is rendered conulose by the outer ends of the skeletal fibres (Pl. xxviii., fig. 6): nevertheless, so coarse and stiff are these fibres that, even in the best-preserved specimens, the surface would almost certainly show some decided visible effect of their impingement on it, and at least would be asperous and harsh to the touch. The conuli are seldom much above $\frac{1}{3}$ mm. in height, very close-set, and of hard feel; they are such that the surface has much the appearance of that of a fine rasp. The dermal membrane is very thin and very closely adherent, accommodating itself exactly to the sharply contoured surface-inequalities; presumably it has undergone considerable contraction, since neither pores nor oscula are detectible. In consistency, owing partly to its somewhat dried and shrunken condition, but perhaps mainly to its very dense skeleton, the specimen is tough and hard, almost incompressible; the branches are stiffly flexible. The colour is brownish-grey on the surface, and dark brown in the interior.

Skeleton.—The prepared skeleton, as seen in its entirety (Pl. xxiii., fig. 9), is of a faintly brownish, light grey colour, and consists of a very stout and solid looking core, with coarse and stiff, bristle-like, short radial fibres projecting therefrom on all sides,

in moderately close array, almost at right angles; when dry, it is hard and brittle. The core occupies never less than half the diameter of the branches, and the radial fibres seldom exceed 1 mm. in length. The latter, which are connected only very sparsely by paucispicular transverse fibres (of a single spicule's length), vary in stoutness from about 110 to 190 μ or so, and are composed almost solely of spicules,—their spongin being insufficient in quantity to form an external sheath, and becoming discernible only after staining. The fibres of the central axis, which also are but very scantily provided with spongin, have their spicules less closely compacted than the radial fibres, and form so dense a lattice-like reticulation that, except in moderately thin sections, the outlines of individual fibres can seldom be distinguished, and open meshes do not appear.

Megascleres.—These are almost exclusively oxea, slightly and usually somewhat angulately curved, fusiform, with gradually and regularly tapered, nearly always acutely-pointed extremities; but strongyla and scarcer styli also occur—more especially in the stalk, where the proportional number of the former may exceed one in fifteen. In the stalk also, occasional anisoxea are

Text-fig. 1. — *Trachycladus scabrosus*. Megascleres: *a*, from the stalk; *b*, from the branches.

met with, as in *T. digitatus* and *T. pustulosus*; and the megascleres are there of notably greater size than elsewhere. The strongyla are mostly not quite cylindrical in shape, but slightly fusiform; they are of lesser length, on the average, than the oxea, and, in the case of the shortest, are relatively much stouter. Although strongyla are present in far greater number than styli, spicules intermediate in form between them and oxea are of less frequent occurrence than those intermediate between styli and oxea. The maximum size of the megascleres is not greater than $480 \times 23\mu$ in the branches, and about $530 \times 28\mu$ in the stalk; the oxea are very rarely less than 330μ in length, and proportionately slender, but the shortest strongyla (which may exceed 20μ in stoutness) fall below 200μ.

Microscleres.—The spirulæ are mostly of between 1 and 2 turns and from 2 to 3μ in stoutness; C-shaped forms are rather scarce, and straight rods rare. The microstrongyla are very scarce, seldom centrotylote, and from 15×3 to $20 \times 5\mu$ in size.

Trachycladus fastigatus, sp.nov.

(Pl. xxi., fig.1; Pl. xxiii., fig.10.)

Diagnosis.—Profusely branched. Branches elongated and tapering; anastomosing at points of contact. Surface smooth and glabrous. Oscula (?). Dermal layer strongly developed, dense, opaque; with closely packed spirulæ forming a layer 70-140μ thick. Inhalant pores dispersed singly. Skeleton with a rather dense axial fune, of diameter generally less than the length of the radial fibres. Radial fibres directed at an angle of from 35° to 60° with the skeleton-axis; very rarely more than 20-25μ in stoutness; their spicules cemented by a scarcely perceptible amount of spongin. Extra-axial connecting fibres few, mostly unispicular. Megascleres almost exclusively diactinal, mostly more or less rounded off at the ends, very commonly approximating in form to strongyla, but nearly always more or less (slightly) fusiform; only slighter, if at all, of greater dimensions in the stalk than elsewhere; in maximum size very rarely exceeding $520 \times 9\mu$, and at most $560 \times 12\mu$. Microstrongyla abundant in some parts, scarce in others.

Loc.—Great Australian Bight.

External features.—The single specimen (Pl. xxi., fig. 1) is of luxuriantly arborescent habit, and measures 360 mm. in total height, being thus the largest example of the genus yet obtained; the number of its ultimate branches exceeds one hundred and fifty. The branches are elongated and relatively slender, gradually tapered, distally much attenuated and flagelliform; the stoutest are at most 8 mm. in diameter at their base. They are richly and, in places, intricately anastomosed, forming thus, as well as by their multitude, a dense and somewhat tangled mass. Unfortunately the specimen, although in alcohol, is not very perfectly preserved, owing to its having temporarily become partially dried (through breakage of the vessel containing it) while in course of transit from the collecting ground. In consequence of this—mainly, if not solely—the branches are without exception much wrinkled longitudinally, presenting a shrivelled appearance: in life, apparently, their outline in cross-section was circular. The dermal layer, notwithstanding, remains intact, and exhibits no outward indication of having been detrimentally affected: it has the form of a dense and tough, opaque membrane or skin, with an outward appearance and texture much resembling that of rubber; is composed almost entirely of closely crowded spirulæ; and is even now (after possible shrinkage) usually between 90 and 120 μ, and occasionally as much as 140 μ, in thickness. Into the dermal membrane the skeletal fibres do not enter, nor do their extremities ever cause the surface to appear granular.

Examined with the naked eye, a transverse section of a branch shows, superficially, a sharply delimited dense layer, 0·2 to 0·4 mm. in width, the appearance of which is extremely suggestive of a cortex. Under the microscope, however, the seeming cortex is seen to consist in part of a layer belonging to the choanosome, which layer, unlike the remainder of the choanosome, is so densely packed with parasitic algal rods as to assume a whitish-opaque appearance similar to that of the dermal layer itself. But, in all probability, this is not a constant feature.

Presumably owing to their having become closed—as a result of the contraction undergone by the specimen—oscula are not indicated: in life, they must, at any rate, have been of very small size. The dermal pores, for the most part, have also disappeared: but traces of them remain, sufficient to show that they are distributed singly as in *T. digitatus* and its varieties.

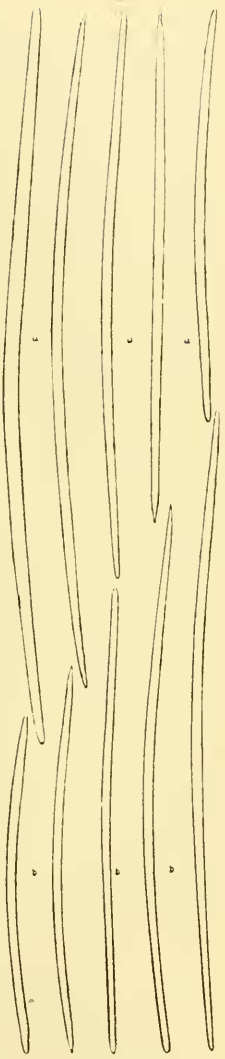
Skeleton.—The prepared skeleton, viewed in the gross (Pl. xxiii., fig. 10), is of a pale creamy-white colour, and shows a sharply-circumscribed, dense core-region, of diameter rarely less than one-third, and frequently exceeding one-half, the total diameter of the branches. The extra-axial skeleton presents somewhat the appearance of fur, being composed apparently only of fine silky-looking *outwardly-directed* (*i.e.*, radial) fibres: under the microscope, however, the radial fibres are mostly found to be connected, though as a rule only at very distant and irregular intervals, by delicate transverse fibres, often in the form merely of single spicules unensheathed by spongin. Even the component spicules of the radial fibres are rarely more than 4- or 5-serial, and the spongin cementing them, seldom sufficient to form a visible sheath, is usually so small in quantity as barely to be perceptible even in stained sections of the skeleton. The main fibres of the axial skeleton, save in the stalk and the basal portions of the older branches, are, for the most part, almost equally deficient in spongin, but the spicules composing them are less compactly arranged than in the radial fibres, and are all mostly somewhat greater in number: they form, with the aid of numerous connecting fibres and spicules, as well as by interunion among themselves, a close and rather intricate meshwork, in which the course of individual main fibres cannot be easily traced.

Megascleres.—The megascleres (which are approximately the same—though, on the average, perhaps not quite so slender—in the stalk as in the branches) comprise a goodly proportion of sharp-pointed oxea: but the great majority are intermediate forms showing every stage of transition between oxea and strongyla; moderately scarce styli also occur. The more sharply pointed spicules are very often irregularly ended, sometimes mucronate.

Their curvature, in proportion to their length, is slight, and often affects only a very limited portion of the central region of the spicule, the actines throughout nearly their whole length remaining straight; they are frequently, therefore, more correctly to be described as symmetrically bent, than as curved. Except in this respect, and in their much greater length, they most resemble, on the whole, the megascleres of *T. digitatus* var. *strongylatus*; the strongyla, however, differ from those of the latter, as well as from those of the other two species in which they occur plentifully, in that they are never quite cylindrical, but always taper slightly, with nearly uniform gradualness, from the middle to either end. Their diameter is rarely more than one-fiftieth of their length, which ranges from about 330 to 560 μ.

Microscleres.—The spirulæ are, without exception, of less than 2 complete turns, and a very considerable proportion (amounting to at least 25%) are of less than 1 turn—*i.e.*, are more or less C-shaped; they frequently attain to 2·5 or 3 μ in stoutness. Rod-shaped derivatives are common, but are very seldom more than 8 μ in length.

The microstrongyla—which in most parts of the sponge are fairly abundant—are, with rare exception, centrotylote and rather slender, very seldom exceeding 2·5 μ in diameter; but occasional stouter ones without the dilatation also occur,



Text-fig. 2.
Trachycladus fastigatus.
Megascleres: *a*, from the stalk; *b*, from the branches.

which attain a diameter of 4 or 5 μ; the length does not exceed 17 μ. Malformed individuals, such as are of frequent occurrence in *T. digitatus* and *T. pustulosus*, are rarely to be found.

Trachycladus digitatus Lendenfeld, et varr.

General diagnosis.—Branches moderately short, cylindrical to clavate, occasionally (abruptly) pointed, but never, so far as known, gradually tapered. Surface even, smooth to faintly granular. Oscula scattered irregularly over the entire surface, or (in the var. *claratus*) arranged, or tending to become arranged, in two longitudinal rows on opposite sides of the branches. Dermal membrane varying (in the different varieties) from 50 to 120 μ in maximal thickness; with closely packed spirulæ throughout its entire thickness (except in the var. *strongylatus*, in which the spirulæ are confined to a superficial layer). Dermal pores dispersed singly, at a distance apart from one another generally greater than their own diameter. Skeleton with moderately dense axial fune of diameter greater or less than the length of the radial fibres. Radial fibres directed at an angle of between 30° and 60° degrees to the axial direction; varying (in different varieties) from 50 to 90 μ in maximal stoutness; with spongin rarely sufficient in quantity to form a distinct ensheathing layer external to the spicules. Megascleres—except in the var. *strongylatus* (in which strongyla are the more numerous)—consisting chiefly or almost exclusively of sharp-pointed oxea; of considerably greater maximum size and generally of more fusiform shape in the stalk of the sponge than in the branches; maximal size in the stalk varying (in different varieties) from not less than $350 \times 10 \mu$ to $530 \times 23 \mu$.

Hab.—South-eastern coast of Australia.

Trachycladus digitatus, typical form.

(Pl. xxii., figs. 1, 2; Pl. xxiii., fig. 1; Pl. xxvi., fig. 2; Pl. xxvii., fig. 1.)

1887. *Spirophora digitata*; Lendenfeld(**26**), p. 794.

1888. *Spirophorella digitata*; Lendenfeld(**27**), p. 236.

1914. *Trachycladus digitatus*; Hallmann(**13**), p. 429.

Diagnosis.—Branches moderately slender (4 to 6 mm. in

diameter): approximately of uniform diameter throughout their length, or slightly pointed terminally. Oscula scattered irregularly. Dermal membrane up to 80 or 90 μ in thickness. Radial fibres of greater length than the diameter of the axial fune; rarely as much as 75 μ in stoutness. Megascleres almost exclusively more or less sharp-pointed oxea, varying in maximal size (in different specimens) from 300×9 to $380 \times 11\,\mu$ in the branches, and from 440×15 to $510 \times 17{\cdot}5\,\mu$ in the branches.

Loc.—Port Jackson.

Introductory.—The following description is based on four specimens (all in the collection of the Australian Museum), two of which are labelled *Spirophora digitata* in Lendenfeld's handwriting. Examination has also been made of a small piece of a British Museum specimen labelled with the same name, and, so far as one can judge from its spiculation,—the fragment being insufficient to provide all the requisite information as regards other characters—this is of the same species. The specimens, nevertheless, are considerably at variance with Lendenfeld's description of *S. digitata*,—according to which the digitate branches are much compressed (4 mm. broad and 2 mm. thick), the surface shows "ein feines Netz erhabener Leisten," and the megascleres are styli. The statement regarding the megascleres one may reasonably presume to be erroneous, inasmuch as styli are otherwise unrecorded as occurring in the genus except sporadically as variants of oxea; but the other discrepancies are only explicable on the assumption either that the specimens (of both Museums) are mislabelled, or that the species is wrongly described in respect of its external characters. The view here taken is that the latter explanation is the true one.* As regards the evidence for the identification of *Spirophorella digitata* with the present species, the reader is referred to a previous paper (**13**, p.429).

* Certainly no implicit reliance can be placed on the description; for it is beyond question that in "Die Chalineen des australischen Gebietes," as already has been proven to be the case in the "Catalogue of Sponges in the Australian Museum," some (if not many) of the descriptions confound two species (by ascribing to the one the external features of the other),

The specimens labelled by Lendenfeld are in a dried and shrivelled condition, and look as if beach-worn, the more exposed portions of the surface being more or less denuded of their dermal layer and appearing as a consequence (owing to the projecting ends of the skeletal fibres) hispid or slightly shaggy. Their appearance is thus considerably different from that of the other two specimens, which are in alcohol and well preserved. As regards the latter, it is to be noted that in one of them, as in the two dried specimens, microstrongyla are present in great abundance, whereas in the other, microstrongyla are extremely scarce; but as both are exceedingly alike in other respects, and, moreover, were collected in the same haul, it is impossible to regard their differences as other than due to individual variation; and it was perhaps owing to Lendenfeld's having examined a specimen provided with only rare microstrongyla that no mention is made of such microscleres in his description of the species.

External features.—The external habit is sufficiently portrayed in the figures (Pl. xxii., figs. 1, 2) illustrating the two better-preserved specimens, the larger of which measures 125 mm. in height. The branches have a diameter of from 4 to 6 mm.; and the peduncle is of about the same stoutness. The surface is smooth, and glabrous or nearly so—the utmost effect occasioned by the impingement of the skeletal fibres upon it being (in the case of the alcoholic examples) a faintly granular appearance here and there; should the sponge be removed from alcohol, however, and allowed partially to dry, the surface assumes a minutely pustulated appearance, much resembling (on a small scale) that of the human tongue. The irregularly, and rather distantly scattered oscula are never much greater than $\frac{1}{4}$ mm. or thereabouts in diameter. Some of the main exhalant canals, in the terminal

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and even the figures cannot always be trusted. In proof of the last assertion, one need only compare, for example, the description with the figure in the cases of the following species:—*Ceraochalina reteplax* (p. 785; Pl. xix., fig. 17); *Euchalinopsis minima* (p. 816; Pl. xviii., fig. 3); *Chalinodendron exiguum* (p. 819; Pl. xxvi., fig. 65); *Chalinodendron minimum* (p. 820; Pl. xxvi., fig. 71); and *Chalinorhaphis digitata* (p. 822; Pl. xxvi., fig. 62).

part of their course, run for a short distance close below the dermal membrane, and, being visible through it, present an appearance as of veins radiating to the oscula. The colour (in spirit) is a faintly yellowish pale grey with the least possible tinge of olive-green; at the same time, the sponge has a slightly subtranslucent appearance, somewhat recalling that of wax. The consistency is rather fleshy, moderately soft, yet fairly tough and elastic; the branches stand firmly erect.

The dermal pores are disposed in the manner shown in Pl. xxvi., fig.2, and Pl. xxvii., fig.1. They vary from 30 to 85μ in diameter, and number, on the average, between 60 and 70 per sq. mm.

Skeleton.—The skeleton, as seen in its entirety (Pl. xxiii., fig.1), is of a light greyish colour, tinted very faintly with brownish pale yellow in the condensed axial region and in its older portions. By reflected light alone, the axial condensation can barely be perceived, being obscured from view by the extra-axial skeleton; but with the opposite illumination,—as when the skeleton is held directly between the eye and the light—it is seen as a sharply delimited, apparently solid core, occupying about one-fourth the diameter of the branches. The extra-axial skeleton appears, at first sight, to consist solely of radially directed fibres—2 to 3 mm. in length—which are inclined to the forward direction of the axis at an angle varying from about 30° in the distal region of the branches to about 45° in the basal; but, on closer inspection, transverse fibres (very rare towards the periphery of the skeleton, but becoming fairly numerous as the axis is approached) connecting these can be made out. The extra-axial skeleton is rather scanty—its effectiveness in concealing from view the axial condensation being due mainly to the very oblique inclination of the radial fibres.

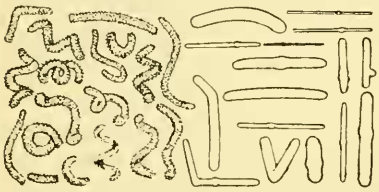
The radial fibres are from 30 to 70μ (rarely more) in stoutness, and, speaking generally, consist almost entirely of megascleres regularly arranged in close parallelism,—the spongin cementing the spicules seldom forming a very well defined sheath, and more usually being so small in quantit as to be

barely discernible unless stained. The main fibres of the axial skeleton are mostly coarser—up to 90 or 100μ in stoutness—and much more sponginous, and the spicules composing them are less compactly arranged; they form by interunion among themselves, and with the aid of numerous short connecting fibres, a dense, lattice-like meshwork, in which the course of the individual fibres is rather difficult to trace. The extra-axial connecting fibres occur at irregular intervals, and are either single (spongin-ensheathed) spicules or, more usually, are composed of several (seldom more than five or six) disorderly-arranged spicules interunited by spongin.

Megascleres.—The megascleres are oxea and relatively few styli, the number of the latter being approximately somewhere between one-fifteenth and one-thirtieth that of the former; among them, an occasional strongyle is also to be met with. They are almost invariably curved,—as a rule a little angulately; are (with the exception of the very stoutest) of uniform, or nearly uniform diameter throughout their length to within 25μ or less of their extremities; and usually taper thence, either regularly or with the intermediacy of one or two more or less abrupt contractions, to a sharp or only slightly rounded-off point. Spicules with much blunted extremities, however, are, in some specimens, by no means uncommon. A certain proportion of the irregularly-ended spicules terminate mucronately. Among the megascleres of the stalk—rarely, if ever, in other parts of the sponge—occasional (yet constantly occurring) ones are met with which taper almost (or, if stylote, quite) from end to end in one direction, *i.e.*, are markedly anisoactinal. In the stalk, also, the megascleres attain to a much greater maximum size than elsewhere, and are often slightly more fusiform in shape. In three of the examined specimens (including among them the one with rare microstrongyla) the megascleres are of approximately the same dimensions—ranging from about 160 (but rarely below 200) to 300μ in length, and up to 9μ in stoutness, in the branches, and attaining a maximum size of 440 × 15μ in the stalk: in the fourth specimen—in which, also, the megascleres

are much more frequently blunt-pointed—they are notably larger, 180 to 370μ long and (at most) 11μ stout in the branches, and occasionally attaining to 510 × 17·5μ in the stalk.

Microscleres.—(i.) The spirulæ (Text-fig.3) are mostly of less than 2 turns, rarely of more than $2\frac{1}{2}$. Rod-shaped derivatives of them, of all lengths between 4 and 23μ, and from 2 to 3·5μ in diameter are fairly common—numbering, say, one to every forty or fifty of the coiled spicules; the latter rarely exceed 2·5μ in diameter.



Text-fig.3.*

(ii.) The microstrongyla are imperfectly differentiated into two kinds: (1) slenderer, invariably centrotylote forms ranging in length from 12 to 27μ and in diameter from less than 1μ up to 3 or 3·5μ, and (2) stouter, rarely centrotylote ones, occasionally as much as 5μ in diameter, and seldom more than 20μ in length. The former are present in great abundance in three of the examined specimens, but are almost, or entirely absent from the fourth; the latter are scarce in all four specimens.

Text-fig.4.†

*Spirulæ and microstrongyla of *Trachycladus digitatus*.

† *Trachycladus digitatus*. Megascleres: *a*, from the stalk; *b*, from the branches.

Abnormal forms among the microstrongyla (of the kind shown in the Text-fig.) are of more frequent occurrence in the present, than in any other of the species excepting *T. pustulosus*, their proportionate number being not less than one in thirty.

Trachycladus digitatus var. gracilis, var.nov.

(Pl. xxii., fig.3; Pl. xxiii., fig.2; Pl. xxvii., fig.2.)

Diagnosis.—Branches slender (2 to 3·5 mm. in diameter); of uniform diameter throughout their length. Oscula scattered irregularly. Dermal layer with closely packed spirulæ throughout its entire thickness. Radial fibres of lesser length than the diameter of the axial fune. Megascleres almost exclusively sharp-pointed oxea; stylote modifications much more frequent in occurrence than strongylote; maximum size, $530 \times 23\mu$ in the stalk, rarely as much as $430 \times 15\mu$ in the branches.

Loc.—Port Jackson.

Occurring in the collection is a single specimen (labelled as from Port Jackson, and well-preserved in alcohol) which, while presenting the more essential features displayed by the typical form of the species, yet differs in many respects so appreciably from the above-described specimens that it seems advisable, provisionally at least, to regard it as constituting a separate variety. The differences which distinguish it externally (Pl. xxii., fig.3) are chiefly these: the cylindrical, untapered branches are comparatively slender, measuring only from 2 to 3·5 mm. in diameter (the specimen itself being 115 mm. in total height); the consistency is very firm, the branches being stiffly flexible and but slightly compressible; and the colour superficially is a subtranslucent slaty-grey. The size and distribution of the pores and of the oscula are much the same as in the typical variety, except that the pores are smaller (not exceeding 65μ in diameter), and their linear reticulate arrangement (Pl. xxvii., fig.2) is more pronounced. As in the typical variety also, the main exhalant canals leading to the oscula are visible through the dermal membrane, presenting an appearance as of veins; but they are here very much more distinct, and are traceable for a much greater distance

from the oscula. The dermal membrane varies from 50 to over 100 (rarely to 130 μ) in thickness, and is closely packed throughout with spirulæ.

The distinctive internal features are the very much greater relative development of the axial fune as compared with the extra-axial skeleton, the slightly stouter and more sponginous fibres, and the greater dimensions of the megascleres. In the first-mentioned respect, as may be seen from the figure (Pl. xxv., fig. 2), the skeleton (which is of a pale brownish-grey tint) approaches rather closely to that of *T. scabrosus*—inasmuch as, throughout the greater part of the length of the branches, the axial condensation occupies not less than three-fourths of their diameter; only towards the extremities of the branches do the radial fibres become distinctly apparent, and even there their length never much exceeds 1 mm. The diameter of the radial fibres varies from 30 to over 80 μ, and their spicules are always surrounded by a well-defined, though usually very thin layer of spongin. The spongin does not extend to the very extremities of the fibres, but terminates quite abruptly a short distance therefrom, leaving the endmost spicules free.

In correspondence with their greater stoutness, the megascleres (*cf.* Text-figs. 4 and 5) are slightly more fusiform than in the typical variety; and their apices

Text-fig. 5.—*Trachycladus digitatus* var. *gracilis*. Megascleres: *a*, from the stalk; *b*, from the branches.

are nearly always sharply and regularly pointed. Styli are of rather frequent occurrence, their proportionate number being approximately one in ten; anisoxea are met with in the stalk and very rarely also in the branches. They range in length from about 280 to 420 or 430 μ (with a maximum stoutness of 14 or 15 μ) in the branches, and up to 530 μ in length by 23 μ in stoutness in the stalk.

The spirulæ and their derivatives are without distinctive features, either as regards size or relative numbers.

The microstrongyla appear to be exclusively of the *stouter* kind occurring in the typical variety, and never centrotylote; they are moderately scarce, and attain a size of 20 by 5 μ.

Trachycladus digitatus var. clavatus, var.nov.

(Pl. xxii., fig.4; Pl. xxiii., fig.3; Pl. xxv., fig.2; Pl. xxvii. fig.3; Pl. xxviii., fig.5; Pl. xxix., fig.1.)

Diagnosis.—Branches gradually increasing in diameter distally, thus becoming elongately club-shaped and attaining to fair stoutness. Oscula in part scattered irregularly, and in part (or sometimes almost without exception) arranged more or less distinctly in two longitudinal series on opposite sides of the branches. Radial fibres generally nearly twice the diameter of the axial fune. Megascleres chiefly sharp-pointed oxea, but intermediate forms between these and strongyla are more or less frequent; stylote modifications comparatively rare; maximum size varying (in different specimens) from 400 × 14 μ to 480 × 17 μ in the stalk, rarely exceeding 300 × 9 μ in the branches.

Loc.—Port Phillip.

This variety is based upon three specimens markedly distinguished from all the remaining available examples of the species by the shape of the branches, which gradually increase in diameter upwards from their base, attaining their maximal stoutness at no great distance from their extremities. Two of the specimens are comprised amongst those recorded by Dendy(7) as examples of *Trachycladus laevispirulifer* Carter,—being, namely, the two (with the reg. nos. 415 and 1046) referred to by him as distinguished from the others by their more robust and stouter

branched habit and the more evident microspination of their spirulæ; the third, which I select as the type-specimen, is in the collection of the Australian Museum.

External characters.—Of the three specimens, two (which are excellently preserved in alcohol)—viz., the Australian Museum specimen and R.N. 1046—are exceedingly alike in all but size; the former (Pl. xxii., fig.4) measures 145 mm. in total height, the latter 100 mm. Their branches are, without exception, circular or nearly so in cross-section, attain a maximal stoutness distally of from 10 to 12 mm., and are seldom more than 5 mm. in diameter at the base; the extremities of the branches are never in the least degree pointed. The surface is perfectly even and glabrous, without the faintest trace of granulation. The oscula are minute, seldom as much as 0·4 mm. in diameter, and for the most part are scattered irregularly; in places, however, they exhibit a tendency towards a longitudinal serial arrangement. Excurrent canals leading to the oscula are not visible through the dermal membrane. The colour in alcohol, both superficially and for some distance interiorly, is an opaque pale creamy-white; proceeding towards the axis, it gradually becomes more yellowish, owing to the closer approximation of the spongin-ensheathed skeletal fibres. The consistency, in the more expanded, distal parts of the branches, is soft and resilient; the branches are flexible and elastic.

The other specimen (R.N. 415), measuring 108 mm. in total height, exhibits the following differences (Pl. xxix., fig.1): (i.) The branches (which vary from 10 to 14 mm. in stoutness) are mostly pointed at the extremities, and rendered irregular by occasional swellings and protuberances (incipient secondary branches); (ii.) the oscula, almost without exception, are arranged along the branches in irregular opposite rows, and the largest are nearly 1 mm. in diameter; (iii.) the surface is minutely wrinkled, and in parts slightly granular; and (iv.) the consistency is comparatively firm and hard, and the branches are brittle rather than flexible. Otherwise, however, with the exception of the single difference mentioned in the next paragraph, the specimen agrees

in all essential respects with the preceding; and, furthermore, the differences (iii.) and (iv.) are, almost undoubtedly, due merely to the fact of the specimen's having been allowed to become partially dried before being placed in alcohol.

Text-fig. 6.*

The pores are notably larger in size than in the two preceding varieties, varying in diameter from 40 to 120μ, and are more uniformly distributed (Pl. xxvii., fig. 3). The dermal layer is from 40 to 90μ in thickness, and, in the case of the two similar specimens, is closely packed throughout with spirulæ. But in R.N. 415, only a superficial layer of the dermis—usually less than 25μ in thickness—is packed with spirulæ, the remaining portion being occupied by numerous parasitic algal cells.

The skeleton presents no appreciable point of difference from that of the typical variety excepting that the radial fibres are generally much longer—their length, in the expanded portions of the branches, being about twice the diameter of the axial fune (Pl. xxv., fig. 3). The fibres attain, at most, a stoutness of 70 to 80μ, but are usually much slenderer, and are always provided with a distinct, though thin sheath of pale-coloured spongin. The skeleton, seen in its entirety, is pale golden-yellowish.

The megascleres of the stalk are scarcely different from those of

* *Trachycladus digitatus* var. *claratus*. Megascleres: *a*, from the stalk; *b*, from the branches.

the typical variety, while those of the branches are different only in the fact that their extremities are most frequently more or less blunt-pointed, and strongylote forms are common. The branch-spicules are of the same dimensions in all three specimens, ranging in length from about 170 to slightly above 300μ and attaining to about 9μ in stoutness: the stalk-spicules have a maximum size, in the type-specimen, of (rarely) 480 × 15μ: in R.N. 1046, of 450 × 17μ; and in R.N. 415, of 400 × 14μ.

The spirulæ are not distinguishable from those of the typical variety. Microstrongyla are rather scarce in R.N. 415, and in the other two specimens are extremely rare or absent; apparently they are never centrotylote, and are at most 15 × 3μ in size. Abnormal forms of the microstrongyla, such as occur in the typical variety, were not observed.

Trachycladus digitatus var. strongylatus, var.nov.

(Pl. xxii., fig.5; Pl. xxiii., fig.4; Pl. xxvi., figs.3,6; Pl. xxvii. fig.4.)

Diagnosis. — Branches cylindrical, untapered, moderately slender. Oscula irregularly scattered. Dermal membrane with closely packed spirulæ confined to a superficial layer seldom as much as 25μ in thickness. Radial fibres of lesser length than the diameter of the axial fume. Megascleres chiefly strongyla and very blunt-pointed oxea,—those in the branches rarely exceeding 290 by 7μ in size.

Loc.—Port Phillip.

This variety is represented by a single incomplete (but excellently preserved) example (Pl. xxii., fig.5)—consisting only of a pair of united branches—the appearance (of the proximal part) of which suggests its having grown from a small broken-off piece of another specimen. As compared with the representatives of the preceding varieties, the specimen is distinguished chiefly by the more or less strongylote character of the majority of its megascleres—in which respect it rather resembles an example of *T. reteporosus*; this statement, however, is possibly true only as regards the megascleres of the branches, since a stalk is lacking. The branches are cylindrical and slender, 3·5 to 5mm. in diameter.

The surface is minutely granular. The oscula are scattered irregularly, and vary in diameter from 0·3 to 0·75 mm. The colour superficially is pale brownish-grey. The dermal pores (Pl. xxvi., figs.3, 6; Pl. xxvii., fig.4) are for the most part scattered singly and irregularly, as in the variety *clavatus*, but here and there, especially on some parts of the surface, they exhibit also a tendency to become arranged several together in incipiently sieve-like groups; they range from 40 to 110μ in diameter. The dermal membrane is rarely, if ever, more than 50 or 60μ in thickness; and the dermal spirulæ are confined to a superficial layer which is at most 25μ in thickness.

Text-fig.7.*

Examined in its entirety, the prepared skeleton (Pl. xxiii., fig.4) is of a pale golden-yellow colour, fine-textured, and of soft feel, and of denser appearance extra-axially than that of any other of the varieties or species owing to the greater number and closer arrangement of the radial and connecting fibres, which quite conceal the axial core from view; the core itself is less dense than that of the other varieties. The radial fibres, which are of slightly lesser length than the diameter of the core, are mostly between 30 and 50μ—rarely as much as 60μ—in stoutness, and are seldom provided with spongin sufficient in quantity to form a distinct ensheathing layer.

The megascleres in the uppermost part of the branches consist almost entirely of strongyla and blunt-pointed oxea (the former somewhat the more numerous), and rarely if ever exceed 300 by 7·5μ in size; the length of the shortest spicules is less than 150μ, and individuals below 200μ in length are common. At the

*'*Trachycladus digitatus* var. *strongylatus*. Megascleres.

lowermost extremity of the (incomplete) specimen, the megascleres are still chiefly strongyla, but they comprise also a quite appreciable number of more or less sharp-pointed oxea, and range in size up to 350 by 10 μ. The spinispirulæ and their more or less rod-shaped derivatives (the latter of which are rather rare) are very seldom, if ever, more than 2 μ in stoutness. Microstrongyla were not observed.

TRACHYCLADUS RETEPOROSUS, sp.nov. (et varr. ?).

General diagnosis.—Branches elongated and tapering. Surface smooth to slightly granular. Oscula entirely, or for the most part, disposed in longitudinal series. Dermal membrane at most 50 μ in thickness; with closely packed spirulæ occurring only in a thin superficial layer. Dermal pores arranged wholly or in part in subcircular sieve-like groups; in any case, the distance separating adjoining pores is generally very much less than their own diameter. Skeleton with a relatively very dense axial fune of diameter equal to or less than the radial fibres. Radial fibres directed at an angle varying from (rarely less than) 45° to nearly 90° to the skeletal axis; never more than about 50 μ in stoutness; generally with a well-defined, though thin spongin-sheath. Megascleres chiefly strongyla and very blunt-pointed oxea, the former somewhat the more numerous; only occasionally slightly larger in the stalk than elsewhere; varying in maximum size (in different specimens) from 290 × 7 to rarely (in the stalk) 330 × 10 μ.

Loc.—Port Phillip.

The specimens which I ascribe to this species exhibit in certain respects considerable variability, so that it is impossible to be certain whether they are representative of several genetically distinct forms or owe their differences merely to individual variation. A second difficulty in connection with the species arises from the fact that, in certain of the specimens, the mode of disposition of the dermal pores approaches somewhat closely to that characteristic of *T. digitatus*, and in others again, owing to their shrunken condition, the pores are not discernible: in the case of these specimens, accordingly,—since no appreciable difference

exists in spiculation between the present species and *T. digitatus* var. *strongylatus*,—the only definitely definable character justifying their inclusion in the present species, rather than in *T. digitatus*, is the elongate tapering habit of their branches. Among the remaining specimens, however, there is one which in various respects stands considerably apart from all the rest, and in these respects also is by far the most divergent from *T. digitatus*. I therefore select this specimen to represent the typical form of the species, and the remainder I refer provisionally to an undesignated variety, leaving the problem of their correct allocation to be determined in the future.

T. RETEPOROSUS, typical form.

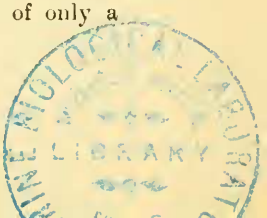
(Pl. xxi., fig.2; Pl. xxiii., fig.5; Pl. xxiv., fig.3; Pl. xxvi., figs.1, 4, 7; Pl. xxvii., fig.5.

The single, excellently preserved specimen (Pl. xxi., fig.2),—which measures 340 mm. in total height—consists of a half-score of long, lax, straight, gradually tapered, main branches (160 to 250 mm. in length), arising dichotomously and sub-dichotomously within a comparatively short distance of the short stalk, and of about the same number of shorter (10 to 120 mm. long), but otherwise similar, sporadically occurring secondary branches. But for overlapping and occasional slight torsion, the branches would be disposed in a single plane, and the habit of the sponge flabellate. The branches, in addition to tapering distally, are also more or less narrowed proximally (attaining their maximum stoutness usually at some considerable distance above their base), and, with the exception of a few of the shorter ones, are generally more or less compressed in the plane of branching; the stoutest measure at most 12 or 13 mm. in the major diameter of their cross-section, and 9 to 10 mm. in the direction at right angles thereto. Anastomosis between the branches does not occur. The oscula, which measure up to 0·75 mm. in diameter, are arranged almost exclusively, though not always very regularly, in two longitudinal series situated on opposite sides of the branches, or occasionally in a single longitudinal series. The surface is smooth and even, without the faintest trace of granu-

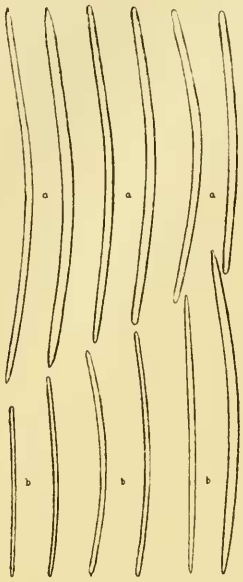
lation; on close inspection, it presents a minutely reticulate appearance due to the dermal pores (Pl. xxvi., fig.4). The dermal membrane is thin and (owing to the multitude and close apposition of the minute pores) of gauzy appearance,— permitting to be perceived through it, more or less distinctly, the subdermal pinhole-like openings which are the entrances of the incurrent canals. The consistency is rather fleshy, soft, and resilient, and the branches are flexible and lax. The colour in alcohol is pale orange-yellow.

The dermal pores are arranged in closely approximated, oval to circular groups or "pore-sieves" (Pl. xxvi., figs.4, 7; Pl. xxvii., fig 5) containing each from 3 to 8 pores, and measuring up to 350μ in diameter; the pores themselves measure from 50 to about 100μ in diameter. Very commonly, the boundaries between the sieves are scarcely more pronounced or wider than those separating the pores, so that, in places, the lines of demarcation between the sieves become obscure and the pores appear almost to be uniformly distributed. Within the pore-sieves, the dermal membrane is extremely thin, and contains but very few spirulæ sparsely scattered.

Skeleton. The skeletal axis or core is much more sharply defined and delimited than in any other of the species, and is equalled in density only by that of *T. fastigatus;* in comparison with the stoutness of the branches, it is rather slender, measuring in diameter generally not more than two-thirds of the length of the radial fibres. The radial fibres proceed outwards from the axis in a direction inclined to it at an angle of 60° and upwards, and arrive at the surface almost perpendicularly thereto. Connecting fibres between the radial fibres are extremely few; consequently, in the prepared or macerated skeleton (Pl xxiii. fig.5), the radial fibres are easily disarranged and thus usually present a somewhat dishevelled appearance. The colour of the skeleton is pearl-grey except axially, where it is brownish-grey. The radial fibres are rarely as much as 50μ in stoutness, and are usually provided with a distinct layer of spongin external to the spicules. The connecting fibres consist frequently of only a single spicule, and seldom of more than two.



Megascleres.—Contrary to what is the case in the other hereindescribed species, *T. fastigatus* excepted, the megascleres are but very rarely, and then only very slightly, of larger size in the stalk than in the branches. They are chiefly strongyla and blunt-pointed oxea approximating more or less in form to strongyla; quite sharp-pointed oxea are comparatively scarce. The strongyla are usually cylindrical or nearly so throughout their whole length, the oxea to within a short distance of their extremities. They attain a maximum size of 300 by 8·5μ. Individuals above 280 by 7μ are rare, and these for the most part are slightly fusiform oxea with more or less sharp-pointed extremities. The shortest spicules are less than 130μ in length, and almost invariably strongyla.



Text-fig. 8.*

Microscleres.—The spirulæ are usually of less than 2 complete turns, rarely, if ever, of as much as 2½; they are somewhat slenderer than those of other species, their diameter very seldom slightly exceeding 1·5μ. Rod-shaped derivatives of the spirulæ, attaining a maximum size of about 17 by 1·7μ, are very scarce.

Microstrongyla are apparently absent.

T. RETEPOROSUS, var. (aut varr. ?).

(Pl. xxi., fig. 3; Pl. xxiii., figs. 6-8; Pl. xxiv., figs. 1, 2; Pl. xxv., fig. 1; Pl. xxviii., figs. 1-4; Pl. xxix., fig. 2.)

The remaining specimens referable, or seemingly referable, to the present species (but distinguished in various respects from the above-described typical example) are eleven in number,—comprising ten of those recorded by Dendy(7) as *T. lævispirulifer*

* *Trachycladus reteporosus.* Megascleres: *a*, from the stalk; *b*, from the branches.

Carter, together with an incomplete specimen occurring in the collection of the Australian Museum: the register-numbers of the former are 297, 366, 426, 470 (two spms.), 983, 984, 1000 (two spms.), and 1061. So far as skeletal features are concerned, the specimens exhibit no marked differences (either among themselves or from the typical example), except in certain details of their microspiculation; but the extra-axial skeleton is somewhat less sparse than in the type-specimen,—as may be observed from a comparison of the figures illustrating the appearance of the entire skeleton,—and the colour of the skeleton (in the denser portions thereof) is not brownish-grey, but varies from pale straw-yellow to light golden-yellow. The megascleres are, in all of them, of approximately the same forms and dimensions as in the typical specimen, the greatest deviation by far occurring in in the case of R.N. 426, in which the megascleres of the stalk attain a maximum size of 325 by 9·5μ, while those of the branches rarely exceed 290 by 7·5μ. All likewise agree with the type-specimen in possessing long and relatively rather slender branches, which attain their maximum stoutness at some distance above their base; and, with rare exceptions, the branches taper more or less distally. On the other hand, in a number of other external features, and especially in the distribution of the dermal pores, considerable variability is displayed. Non-anastomosis between the branches is the rule. The colour, except in one instance, is some shade of pale yellowish-grey.

Exact resemblance to the typical specimen, as regards the mode of disposition of the dermal pores, is shown only by the incomplete specimen which is in the collection of the Australian Museum. In this specimen, the surface is somewhat ruggedly uneven (Pl. xxi., fig.3), the branches (with a maximum stoutness of only 8mm.) are not at all flattened, and the colour is a slightly salmon-pinkish stone-grey. Microstrongyla are absent. (A photograph of the macerated skeleton is shown in Pl. xxiii., fig.6).

R.N. 1061 approaches the typical specimen in general habit (Pl. xxiv., fig.1), but the branches are much less tapered (occasionally of nearly uniform diameter throughout their length), the surface is faintly granular and somewhat uneven, and the oscula

are almost as frequently scattered as arranged serially; the consistency, also, is comparatively firm. The branches vary from (rarely) cylindrical to much compressed, and are usually somewhat lenticular in cross-section. The pores are almost or quite as closely situated and numerous as in the typical specimen, but for the most part they are not arranged distinctly in groups. The spirulæ are peculiar in the fact that they are much less closely coiled than in any other example of the genus, the shape of most of them approaching more or less to that of a contort S; more or less C- or (-shaped forms are also common, but straight or nearly straight rods are extremely rare. Scarce (though by no means rare) microstrongyla are present, varying from 9 to 16μ in length and from 2 to 4μ in stoutness, and almost invariably centrotylote. (A photograph of the macerated skeleton is reproduced in Pl. xxiii., fig.8).

The two specimens R.N. 1000 are much alike in general habit, — which probably accounts for their being registered under the same number, — and differ from all the other specimens, with the exception of R.N. 362, 983, and 984, by the occasional coalescence of their branches: the branches are slender (5 to 8 mm. in diameter), gradually tapered, and not at all compressed: and the surface is somewhat uneven and slightly granular. Nevertheless, in one of the specimens the pores are arranged (Pl. xxviii., fig.2) very nearly as in the typical specimen, while in the other they are distributed singly (Pl. xxviii , fig.1) almost in the same manner as in *T. digitatus*. In both, microstrongyla are exceedingly rare.

In R.N. 983 and 984 the arrangement of the pores (Pl. xxviii., figs.3, 4) is intermediate between that obtaining in R.N. 1061 and that characteristic of *T. digitatus* var. *strongylatus*. The former specimen consists solely of two long branches (one simple, the other with a partially coalescent secondary branch towards its upper extremity), measuring respectively 200 and 300 mm. in length, and both arising almost independently from a small common disc of attachment without the intervention of a stalk. The branches are only 4 mm. in diameter proximally and increase in stoutness upwards very gradually, the larger one attaining a

maximum diameter of 12 mm. at a distance of about 50 mm. from its apex, and thence gradually tapering to a point, the smaller one 8 mm. in greatest stoutness and distally untapered. The other specimen, R.N. 984, consists only of a broken-off pair of fused branches somewhat similar to those just described.

R.N. 426 is in one respect unique: the surface is finely hispid, being rendered so by the extremities of the radial skeletal fibres, which everywhere project $\frac{1}{2}$ to 1 mm. beyond it, presenting the appearance of delicate hairs. Furthermore, although the specimen appears to be excellently preserved, the dermal pores have entirely disappeared, and even the oscula are completely closed. Since the skeletal fibres are altogether too slender and weak to be considered capable of withstanding the bending strain which a shrinkage of the sponge due to the action of the preservative fluid would exert, the peculiar condition of the specimen must almost certainly be the result of contraction while in the living condition. In general outward habit, as is evident from the figure (Pl. xxiv., fig.2), this specimen rather resembles the typical specimen. Scarce strongyla are present, similar to those of R.N. 1061.

The two specimens R.N. 470 consist each of only a few detached branches, which, apart from being non-hispid, are exactly similar in every way to those of the preceding specimen. In one of these specimens, no microstrongyla were observed; in the other (and in this alone of all the specimens) they are fairly abundant, resembling in form and size those of R.N. 1061. (A photograph of the macerated skeleton is shown in Pl. xxiii., fig.7).

In R.N. 297 and 366, — both of which are in a dried, much shrunken condition, and consequently afford no information regarding the pores, — the spirulæ are distinguished by being mostly of less than one complete turn and hence more or less C-shaped; straight rods of all lengths from 3 to upwards of 15μ are also common, especially the shorter ones. R.N. 366 consists of a main stem or branch, about 200 mm. in length, attached by its base (which spreads to form a thin incrusting disc about 4 mm. in area) to the surface of a shell, and sending off on one side, at the distances of 50, 60, and 80 mm. respectively from its

base, three secondary branches which become coalescent with one another. R.N. 297 is unique in consisting solely of a long slender unbranched stem, 250 mm. in length. In both specimens the extremities are tapered. In neither were microstrongyla observed.

Trachycladus pustulosus, sp.nov.

(Pl. xxi., fig.5; Pl. xxvi., figs.5, 8; Pl. xxvii. fig.6; Pl. xxxix., figs.6, 7.)

1887. (?)*Spirophora bacterium* Lendenfeld (**26**), p.795.

Diagnosis.—Branches quite short and distally expanded: sometimes so abbreviated as to be little more than mammiform lobes. Surface closely studded with small pimple-like elevations, and exhibiting, on close inspection, a minute reticulate pattern due to the mode of arrangement of the dermal pores. Oscula situated only on the more distal parts of the branches. Dermal pores arranged in close-set, subcircular, sieve-like groups, usually with from 3 to 7 pores in each group. Dermal layer loosely packed with spirulæ usually throughout its entire thickness—which varies from 40 to 80μ. Skeleton in the upper, more expanded, parts of the branches not forming an axial fune. Fibres stout, and provided with much spongin. Megascleres in the upper parts of the branches consisting almost exclusively of strongyla and oxea in about equal numbers, and rarely attaining to 320 × 9μ in size; peduncular megascleres chiefly oxea (together with occasional styli and only rare strongyla), attaining a maximum size of 460 × 15μ. Microstrongyla extremely abundant, frequently assuming various abnormal shapes, and in part reduced to spheres.

Loc.—Port Phillip.

This species,—of which two well-preserved specimens are at hand, one incomplete, consisting only of a few branches,—is characterised especially by its short stunted branches and very noticeably pimpled surface, and by the fact that the skeleton, except in the stalk and the lowermost part of the longer branches, is only slightly or not at all condensed axially (Pl. xxxix., fig.6). Whilst these features sharply mark it off from all the other

known species, it is still further distinguished by having the pores arranged in sieve-like groups (Pl. xxvi., fig.5)—in which respect it is approached only by *T. reteporosus*—and by the reduction of the microstrongyla in part to spheres. An adequate idea of the external habit will be obtained by reference to the figure (Pl. xxi., fig.5) of the single complete example, which measures 60 mm. in total height: in the case of the other specimen, the branches are somewhat longer, several of them attaining a length of 25 mm. The colour in alcohol is a minutely mottled, slightly brownish pale grey, and the consistency is firm, fairly tough, compressible and resilient.

The surface-pimples,—which coincide in position with, and to some extent are the expression of, the points of impingement of the skeletal fibres upon the dermal membrane,—are fairly uniformly distributed over the whole surface at a distance apart approximating to their own breadth, which on the average is about 0·4 mm.; they are rounded or flattened above, not conule-like, and are conspicuous not so much by the amount of their projection—which at the most is but slight—as by their whitish colour and more opaque appearance compared with the intervening portions of the surface. At the locations of the small areas formed by these elevations, the dermal membrane is closely adherent and non-porous; but between them it overlies subdermal spaces, and is so perforated by numerous small pore-sieves as to appear minutely reticulate. The pore-sieves (Pl. xxvi., fig.7; Pl. xxvii., fig.6), are oval to circular in outline and generally between 40 and 120μ in distance apart, range from less than 100 up to about 200μ in diameter, and contain each, according to their size, from 2 to 8 pores of diameter varying from 20 to 60μ.

Skeleton.—Except in the stalk and the lower portions of some of the lower branches, the skeleton exhibits no well-marked axial condensation or core, but is rather of the dendritic type (Pl. xxxix., fig.7) consisting chiefly of longitudinally-running and of gradually outward-trending, continually branching main fibres, which are not distinguishable as axial and radial respectively; transverse or connecting fibres are numerous between the main

fibres in the central region of the branches, but comparatively scarce and somewhat irregular in occurrence towards their surface The main fibres attain a stoutness occasionally of nearly 200μ in the axial region of the skeleton, but diminish in diameter peripherally to between 60 and 100μ; they are composed of somewhat loosely and irregularly packed spicules united by abundant spongin-cement. The connecting fibres are usually less than 50μ in stoutness and are composed almost entirely of spongin. The spongin shrinks considerably on drying, so that in the dried skeleton the stoutness of the fibres is much less than stated above. The skeleton seen in its entirety (Pl. xxxix., fig 6) is of a golden-yellow colour.

Text-fig. 9.—*Trachycladus pustulosus*. Megascleres: *a*, from the stalk; *b*, from the branches.

Megascleres.—The differences between the megascleres of the stalk and of the branches are more marked than in any other of the species herein described, the former consisting almost entirely of sharp-pointed oxea, ranging from seldom less than 250 up to 460μ in length and up to 16μ in stoutness, and very similar in form and size to those of *T. digitatus* var. *strongylatus*, while the latter are strongyla and more or less blunt-pointed oxea —the strongyla being if anything somewhat the more numerous— ranging in length from occasionally less than 150μ up to about 320 or 330μ, and seldom exceeding 8·5 or 9μ in stoutness. Occasional styli are met with, which are most frequent among the peduncular megascleres; among the latter also anisoxea are not uncommon.

Microscleres.— The spirulæ are of all forms between corkscrew-spirals of a little more than 2 turns and straight rods, the latter fairly common and mostly between 12 and 25μ in length and from 2 to 3·5μ in diameter. The spirulæ are less closely coiled than in any other of the species, and are also slightly larger (occasionally attaining to 18μ in length).

The microstrongyla are rarely less than 2 or more than 3·5μ in diameter, and of all lengths up to 18μ; a notable proportion are reduced to spherulæ. They are mostly not centrotylote. Abnormal forms of various shapes are rather common.

EXPLANATION OF PLATES XXI.-XXIX., figs.1-2; XXXIX., figs.6-7.

Plate xxi.

Fig.1.—*Trachycladus fastigatus*, sp.nov.; from the (partially dried) type-specimen; ($\times \frac{3}{8}$).

Fig.2.—*T. reteporosus*, sp.nov.; from the type-specimen; ($\times \frac{1}{3}$).

Fig.3.—*T. reteporosus*, sp.nov. (var. ?); from an incomplete specimen with slightly rugose surface; ($\times \frac{1}{2}$). (*Cf.* also Pl. xxiv., figs.1-2.

Fig.4.—*T. scabrosus*, sp.nov.; from the type-specimen; ($\times \frac{3}{5}$).

Fig 5.—*T. pustulosus*, sp.nov.; from the type-specimen; ($\times \frac{4}{5}$ nearly).

Plate xxii.

Figs.1-2.—*Trachycladus digitatus* Lendenfeld, typical form; ($\times \frac{5}{8}$ approx.).

Fig.3.—*T. digitatus* var. *gracilis*, var.nov.; from the type-specimen; ($\times \frac{5}{6}$).

Fig.4.—*T. digitatus* var. *claratus*, var.nov.; from the type-specimen; ($\times \frac{3}{4}$ nearly).

Fig.5.—*T. digitatus* var. *strongylatus*, var.nov.; from the (incomplete ?) type-specimen; ($\times \frac{9}{10}$).

Plate xxiii.

Fig.1.—*Trachycladus digitatus* Lendenfeld, typical form; skeleton; (nat. size).

Fig.2.—*T. digitatus* var. *gracilis*, var.nov.; skeleton; (nat. size).

Fig.3.—*T. digitatus* var. *claratus*, var.nov.; skeleton; (nat. size).

Fig.4.—*T. digitatus* var. *strongylatus*, var.nov.; skeleton; (nat. size).

Figs.5-6.—*T. reteporosus*, sp.nov.; skeleton (of the type-specimen and of the specimen illustrated in Pl. xxi., fig.3, respectively); (nat. size).

Figs.7-8.—*T. reteporosus*, sp.nov., (var. ?); skeleton (of the specimens figured in Pl. xxiv., figs.1-2); (nat. size).

Fig.9.—*T. scabrosus*, sp.nov.; skeleton; (nat. size).

Fig.10.—*T. fastigatus*, sp.nov.; skeleton; (nat. size).

Plate xxiv.

Fig. 1.—*Trachycladus reteporosus*, sp.nov., (var. ?); R.N.1061; ($\times \frac{1}{2}$).

Fig. 2.—*T. reteporosus*, sp.nov., (var. ?); R.N.426 (a specimen in which the dermal pores could not be seen); ($\times \frac{1}{2}$).

Fig. 3.—*T. reteporosus*, sp.nov., typical form; one-half of a (desilicified) longitudinal median section of a branch of the type-specimen, showing the dermal layer (in part torn away), subdermal spaces, excurrent and incurrent canals, flagellated chambers, and (on the left) portion of the axial skeleton; ($\times 18$).

Plate xxv.

Fig. 1.—*Trachycladus reteporosus*, sp.nov., (var. ?); longitudinal median section of the skeleton; ($\times 10$).

Fig. 2.—*T. digitatus* Lendenfeld, var. *claratus*, var.nov.; portion (slightly less than one-half) of a transverse section of a branch, showing the arrangement of the flagellated chambers, etc.; ($\times 18$).

Plate xxvi.

Fig. 1.—*Trachycladus reteporosus*, sp.nov., (typical form); longitudinal median section of the skeleton, showing the pattern of the axial fune; ($\times 10$).

Fig. 2.—*T. digitatus* Lendenfeld, (typical form); portion of the surface (from part of which the dermal membrane has been pared off) showing the disposition of the dermal pores, and also of the main incurrent canals; ($\times 6$).

Fig. 3.—*T. digitatus* var. *strongylatus*, var.nov.; portion of the surface, showing the arrangement of the dermal pores and the character of the oscula; ($\times 6$).

Fig. 4.—*T. reteporosus*, sp.nov.; portion of the surface, showing the arrangement of the dermal pores; ($\times 6$).

Fig. 5.—*T. pustulosus*, sp.nov.; portion of the surface, showing the arrangement of the dermal pores; ($\times 6$).

Fig. 6.—*T. digitatus* var. *strongylatus*, var.nov.; portion of the surface, showing the arrangement of the dermal pores; ($\times 20$). (From a drawing).

Fig. 7.—*T. reteporosus*, sp.nov., (typical form); portion of the surface, showing the arrangement of the dermal pores; ($\times 30$). (From a drawing).

Fig. 8.—*T. pustulosus*, sp.nov.; portion of the surface, showing the arrangement of the dermal pores; ($\times 30$). (From a drawing).

Fig. 9.—*T. digitatus* Lendenfeld, var. *gracilis*, var.nov.; moderately thick, transverse section of a branch; ($\times 18$).

Plate xxvii.

Fig.1.—*Trachycladus digitatus* Lendenfeld, (typical form); surface-section, showing the arrangement of the dermal pores; (×40).

Fig.2.—*T. digitatus* var. *gracilis*, var.nov.; surface-section, showing the arrangement of the dermal pores; (×40).

Fig.3.—*T. digitatus* var. *claratus*, var.nov.; surface-section, showing the arrangement of the dermal pores; (×40).

Fig.4.—*T. digitatus* var. *strongylatus*, var.nov.; surface-section, showing the arrangement of the dermal pores; (×40).

Fig.5.—*T. reteporosus*, sp.nov., (typical form); surface-section, showing the arrangement of the dermal pores; (×40).

Fig.6.—*T. pustulosus*, sp.nov.; surface-section, showing the arrangement of the dermal pores; (×40).

Plate xxviii.

Fig.1.—*Trachycladus reteporosus*, sp.nov., (var. ?); portion of the surface (of one of the specimens R.N.1000) showing the arrangement of the dermal pores; (×40).

Fig.2.—*T. reteporosus*, sp.nov., (var. ?); surface-section (of R.N.1061), showing the arrangement of the dermal pores; (×40).

Figs.3, 4.—*T. reteporosus*, sp.nov., (var. ?); surface-sections (of the specimens R.N. 983, 984), showing the arrangement of the dermal pores; (×40).

Fig.5. *T. digitatus* Lendenfeld, var. *claratus*, var.nov.: rather thin (undesilicified) transverse section of a branch; (×15).

Fig.6.—*T. scabrosus*, sp.nov.; rather thin (desilicified) transverse section of a branch; (×20).

Plate xxix., figs.1-2.

Fig.1.—*Trachycladus digitatus* Lendenfeld, var. *claratus*(?), var.nov.; specimen R.N.415; (×½).

Fig.2.—*T. reteporosus*, sp.nov., (var.?); thin, transverse section of a branch (of specimen R.N.1000); (×15).

Plate xxxix, figs.6-7.

Fig.6.—*Trachycladus pustulosus*, sp.nov.; skeleton photographed by transmitted light; (nat. size).

Fig.7.—*T. pustulosus*, sp.nov.; showing pattern of the skeleton as seen in thin longitudinal section (passing through three branches and the upper part of their common stem); (×5).